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NONRESPONSE IN A MAII SURVEY

OF

NAVAL PERSONNEL

by

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Nonresponse in a Mail Survey of Naval Personnel

by

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TABLE OF CONTENTS

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I. INTRODUCTION

The recent advances in technology still have not precluded the need for Navy program managers to obtain meaningful feedback to supplement their decision-making processes. For it is these program managers who daily make decisions which influence many thousands of Navy personnel in regard to job satisfaction and/or career motivation.

The NAVY PERSONNEL SURVEY series was established so that information might be gathered for use by Navy managers in the evaluation of personnel plans and programs and in the formulation of Navy policy. Periodic Navy-wide sample surveys are used to systematically collect attitude and opinion data from Navy personnel. Commenting on the Navy Personnel Survey 1969-1 (NPS 69-1), VADM Charles K. Duncan, then Chief of Naval Personnel, wrote, " ... These surveys are actually conduits for the transmission of the attitudes of a large segment of our Navy population. Let us listen to what they are saying and be guided to the maximum feasible extent by this fleet and shore feedback."[1]

The successful operation of a large-scale sample survey is not a simple undertaking. The mailed questionnaire is a common technique of surveys because of the economies involved. However, a frequent objection to this method of collecting factual information is that it may involve

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[1] Naval Personnel Research and Development Laboratory WSR 71-3, Report of Enlisted Findings Navy Personnel Survey NPS 69-1, by Claude Braunstein, p. iii, August 1970.

a large nonresponse rate, and an unknown bias in the assumption that those responding are representative of the combined total of respondents and nonrespondents.

II. PROBLEM

The mailed questionnaire is widely used as a technique for gathering desired information, especially in the social sciences. This instrument of research allows one to reach a large group of individuals and cover a wide area, both geographically and culturally, for a relatively low cost. Other advantages to the mailed questionnaire include elimination of interviewer bias, possible gain in validity by assurance of anonymity, and hopefully, greater consideration by the individual in making his responses.

NPS 69-1 was the seventh survey in the Navy Personnel Survey series. The survey questionnaires were mailed directly to 24,900 enlisted personnel on 20 June 1969 (officers were also included in the survey but were not considered for the purposes of this research). The importance of answering the questionnaire was stressed and the men were asked to return the self-sealing pre-addressed answer sheet directly to the Naval Personnel Research and Development Laboratory within five days of receipt. A follow-up letter, together with a duplicate questionnaire, was sent to all nonrespondents five weeks after the initial mailing. Returns were accepted through 29 August 1969.

The fact that response was purely voluntary introduced a risk of bias in the results due to nonresponse. In general, researchers appear to be in agreement that nonrespondents do differ in some ways from the respondents.

The problem then is to determine if these differences tend to bias the survey results, and, unless the nature of this bias is not determined, it is then not possible to use the answers of the respondents alone to generalize about the entire population.

This paper cannot attempt to solve the bias problem explicitly since the data analyzed did not include information on how the respondents answered the questionnaire on an individual basis nor on how the nonrespondents would have replied had they answered the questionnaire. It does, however, seek to identify demographic variables whose values are correlated with frequency of nonresponse. Since the analysis lacked data specifically related to response, it was not possible to investigate the nature or magnitude of bias. Ideally, this study has created a framework under which bias can be studied as well as an identification of those areas where factors can be applied to allow for variability in frequency of response.

The major premise considered herein is that successful Naval personnel respond with a greater frequency than do those who are less successful. A scheme for classifying personnel into success categories is developed to examine the claim. The final section presents two methods for measuring bias in mail surveys when there is only one variable under consideration in the survey.

III. LITERATURE REVIEW

Although a review of the literature reveals differing views on the validity of mailed questionnaires, the general consensus appears to be that people who reply to a questionnaire in many instances are different from those who do not reply. Some researchers felt that the mailed questionnaire approach is effective only when sampling within a "homogeneous" group. Clausen and Ford, in particular, indicated that a small percentage of nonresponse may be relatively unimportant if one is working with a homogeneous group. However, the literature has been lacking in specific guidelines for defining "homogeneous" in the context of response bias. The following constitutes Clausen and Ford's attempt at a definition:

> "If we define a homogeneous group by any criteria other than the characteristic which is to be estimated and there will still be cleavages within the group...
> The crux of the problem of working with a homogeneous group is this: How do you know they are homogeneous with respect to the relevant characteristics (including interests) until you have made a study of a representative segment of the group?" [2]

In a similar context Goode and Hatt reported, "The central point ... necessary to underline is the fact that the mailed questionnaire is not an effective research tool for any but a highly select group of respondents."[3]

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[2]Clausen, J.A., and Ford, R.N., "Controlling Bias in Mail Questionnaires," Journal of American Statistical Assoc., v. 42, p. 497-511, 1947.

[3]Goode, William J., and Hatt, Paul K., Methods in Social Research, p. 174, McGraw Hill, 1952.

Here too, the concept of a highly select group has gone relatively undefined. Certainly there exists sufficient reason for believing that the sample for the NPS series would constitute such a group.

A study conducted in the early 1940's by C. F. Reuss found that certain marked differences existed between respondents and nonrespondents to a mailed questionnaire. Some of Reuss's conclusions on his respondent population will be especially applicable to the respondents of the NPS series.

The subjects of the Reuss study were members of the 1936 freshman class at the State College of Washington. A wealth of background information was available on all subjects from records in the Registrar's office. An analysis of both groups of respondents on the basis of their background variables showed that "higher intelligence scores and scholarships, loyalty or ties to the questionnaire sponsor, and a rural background seem to be positively associated with the tendency to respond."[4] Loyalty or ties to the sponsor was thought to be a function of length of stay in college. Those individuals who had stayed in college for at least three years were more likely to answer the questionnaire than those who left after a shorter length of time. In addition, more than one-third (37%) of the responding group, but less than one-sixth (14.7%) of those not responding had received a degree from the State College. Hence, it was thought that length

[4]Reuss, Carl F., "Differences Between Persons Responding and not Responding to a Mailed Questionnaire," American Sociological Review, v. 8, p. 433-438, 1943.

of stay and the influence of the degree suggested a feeling of loyalty to the institution which was a factor strongly influencing questionnaire response. In conclusion, Reuss notes, "...unless a substantial proportion of coverage is secured, the returns from the mailed questionnaire cannot be assumed to be adequately representative of the universe from which they are drawn." Noteworthy was that Reuss did not define what he meant by "a substantial proportion," although his study secured a 67 percent response rate.

Since the concept of loyalty or ties with the sponsor will be evident in the results of this study, it would be of interest to consider another survey that drew similar conclusions. Edgerton, Butt, and Norman conducted a study of contestants involved in the First Annual Science Talent Search.[5] They classified the contestants into three classes: Winners, Honorable Mentions, and Others. Response to a questionnaire sent out by Science Service, the sponsoring agency for the Talent Search, indicated that the winning contestants made almost perfect returns, the Honorable Mentions group made the next largest percentage of returns, and the Others had the lowest percentage of returns. In addition to the loyalty to the sponsor concept, the authors felt that an interest in the subject matter of the questionnaire (science in general) as evidenced by winners being perhaps "more interested," was also a factor. Note also that their

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[5]Edgerton, Harold A., Butt, Steuart H., and Norman, Ralph D., "Objective Differences Among Various Types of Respondents to a Mailed Questionnaire," American Sociological Review, v. 12, p. 435-444, 1947.

classification of contestants could be considered as a success indicator with the more successful individuals (winners) responding with the greater frequency. The authors recommended stressing intensive follow-up to mail questionnaire research since "... the tendency will be to obtain replies from those who have a special interest in the subject under study, or who exhibit some characteristics or characteristic different from non-respondents or from the casual or indifferent respondents."

A team of researchers who support the claim that there are no differences between respondents and nonrespondents are McDonagh and Rosemblum. They selected a 10 percent random subsample from subjects who completed their questionnaires and from those who did not complete them. A team of interviewers was carefully chosen to conduct the field research of the two subsamples. Key questions in both the questionnaire and interview approaches were identical. They found no statistically significant differences between the respondents and nonrespondents. Hence, their study suggests that the mailed questionnaire may reveal representative responses in spite of partial return from the sample selected. The authors concluded:

> "... there were no significant differences between the responses of the mailed questionnaire and those of the interviewed respondents who had not answered the questionnaire. The nonrespondents did not seem to be so selective of some variables as many behavioral scientists assume. The findings of this study imply

> that reseaichers should have greater confidence in the questionnaires method as an initial tool of research."[6]

Since the data used for this paper consisted primarily of demographic variables on the personnel from the survey sample, it was thought that the comments of C. R. Bell would be appropriate for this review.[7] He noted a lack by any reseacher to attempt a systematic description of the volunteer. He decided to divide the variables examined for their association with volunteer bias into three categories: sociological, psychological, and other, which included the "mechanics" of the questionnaire itself. Some of the sociological variables included age, ethnic background, marital status, occupational status, sex, years at school, etc. Bell's conclusion on these variables was that those studied and conclusions drawn are rarely the same in any two reports. In certain studies some variables are shown to be associated with bias and in others they are shown not to be. In addition, some of the variables cited may be factors relevant to physical availability at the time of the survey (e.g. young mothers and elderly retired persons may deceptively appear to be "volunteers" when merely they are those who are rarely not-at-home when the interviewer calls).

Some of the psychological variables used to describe a volunteer included better adjusted, more drive, more interest in the topic, lonesome, more articulate, etc. Bell notes that attempts to characterize the volunteer

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[6] McDonagh, E.D., and Rosenblum, A.L., "A Comparison of Mailed Questionnaires and Subsequent Structured Interviews," Public Opinion Quarterly, v. 29, p. 131-136, 1965.

[7] Bell, C.R., "Psychological Versus Sociological Variables in Studies of Volunteer Bias in Surveys," Journal of Applied Psychology, v. 45, p. 80-85 1961.

using these types of variables have been hardly more fruitful than with sociological variables. The most acute problem seems to be translating the findings expressed in personality tests jargon into a meaningful context outside the laboratory (e.g. it is not easy for the market researcher to usefully convert such descriptions of the volunteer as one having "a greater self-discipline and tolerance of others").

Observing trends in data from repeated mailings has received some attention in the literature as a device for learning something about the nonrespondents in a mail survey. As an example, consider the survey conducted by Huddleston of 3,241 North Carolina fruitgrowers.[8] The average number of fruit trees per farm (hereafter referred to as $\bar{X}$) was known to be 329. However, the results showed some interesting characteristics. The first mailing yielded just 300 returns with $\bar{X} = 456$. A second request to the remainder of the list yielded 543 returns with $\bar{X} = 382$. The third and last request yielded 434 returns with $\bar{X} = 340$. The value of $\bar{X}$ in every case refers only to the farms who responded to that particular request. Noteworthy was the $\bar{X}$ in each wave of returns becomes progressively smaller but yet it still overestimates the known true value. The author indicated that, on the average, farms having large numbers of fruit trees are more willing to respond than farms having smaller numbers of trees. He concluded that a farmer's interest in a fruit survey can thus logically be expected to be positively correlated with his scale of operations in the fruit business.

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[8]Huddleston, H.F., "Methods used in a survey of orchards," Agricultural Economics Research, vol. 2, pp. 126-130, 1950.

A mail survey conducted on 1,189 Grade A milk producers in North Carolina produced results in which the selectivity of the mail returns was in the opposite direction.[9] In this survey it was known that the average number of cows per farm (hereafter referred to as $\bar{Y}$) for all 1,189 farms was 24.27.

The first mailing yielded 165 returns with $\bar{Y} = 23.03$. A second request received 170 returns with $\bar{Y} = 23.79$. The third and final request yielded 114 returns with $\bar{Y} = 24.23$. As before, the value of $\bar{Y}$ refers only to the farms who responded to that particular request. The bias of the mail returns with respect to cows per farm was not as large as the bias in the fruit trees survey. However, the interesting aspect of the bias was that farms with smaller numbers of cows were the more willing to respond! This would appear contradictory to the results from the previous survey where a farmer's interest in reporting increased with the scale of his operations. The author noted that while there were factors such as scale of operations which induced a farmer to report, there were also other factors pulling in the opposite direction at the same time. Finkner's conclusion was that the amount of work and time required to fill out the questionnaire increased as the scale of operations increased and that this apparently created negative influences for completing the questionnaire.

No review of the literature on mail surveys would be complete without at least some mention of the Literary Digest fiasco of 1936. During

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[9]Finkner, A.L., "Adjustments for nonresponse bias in a rural mailed survey," Agricultural Economics Research, vol. 4, pp. 77-82, 1952.

the 1920's and early 1930's the Digest polled millions of citizens with postcard ballots and had established a fairly accurate record. For example, in 1932 it differed by less than 1 percentage point in predicting the vote for Roosevelt. In 1936, however, it made a very large error of 19 percentage points in predicting Roosevelt's vote. Approximately 20% of the ballots mailed out were returned to the Digest. From a mailing of ten million or more it received some two million ballots yet this huge mail vote was so in error that the poll was disestablished.

F. F. Stephan noted the following in his review of the Digest's dilemma:

> "There is general agreement that this mail-ballot method was subject to a serious distortion because the better educated and more literate part of the population, as well as those who were higher on the economic scale, tended to return their ballots in greater proportion than those who were lower in educational and economic status. In addition, the Digest obtained the names of persons to whom they mailed the ballots from automobile registration lists, telephone directories, and similar sources. These sources were biased upward in education and economic status."[10]

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[10] Mosteller, and others, The Pre-election Polls of 1948, p. 10 Social Science Research Council, New York. 1949.

IV. DESCRIPTION OF DATA

This study utilized data from the NPS 69-1 sample since the men participating in that survey were identifiable by service number, hence, it was possible to separate the respondents from the nonrespondents.

The data consisted of various demographic variables that were available on each sample member from the Naval Personnel Research and Development Laboratory's tape of extracts of the Enlisted Master Tape from 1969. These variables and a description of their content are as follows[11]:

Rate Code - a 5-character alpha/numeric code which is the equivalent of the rate abbreviation.

General Classification Test Score (GCT) - a 2-digit numerical Navy standard score which indicates an individual's ability to understand words and relationships between words, thus indirectly measuring reasoning ability.

Education Level - a 1-character alphabetic code indicating degree/diploma received.

TAR/STAR/SCORE Indicator (TSS) - a 1-character alphabetic code used to identify personnel serving under, or formerly under, the following programs: Training and Administrations of Reserves (TAR)

[11] Manual of the Active Duty Enlisted Master Magnetic Tape Record, NAVPERS 15,949C, Bureau of Naval Personnel, July, 1968.

Selective Training and Retention (STAR)

Selective Conversion and Retention (SCORE)

Expiration of Active Obligated Service (EAOS) - a 6-digit numeric code indicating the date current enlistment expires.

TERM ENLISTMENT - a 1-character numeric code which indicates the number of years for which an individual is currently enlisted.

NOENL - a 1-character numeric code which indicates the number of enlistments in which an individual is presently serving.

Date of Birth - a 6-digit date (last two digits of year, month, day) which indicates the birth date of an individual as recorded in his enlistment contract.

Dependents - a 1-character alpha or numeric code reflecting primary dependents.

Current Enlistment Date - a 6-digit date which indicates when an individual commenced his current enlistment, as recorded in his enlistment contract.

BUPERS Activity Code - a 10-digit numeric code identifying an activity.

Sea/Shore Code - a 1-character numeric code which indicates sea or shore classification of an activity.

Homeport Code - a 1-character alpha or numeric code which identifies the general area of the official home port of a ship, or permanent duty station of an aviation unit, certain staffs, etc.

Race Code - a 1-digit code indicating an enlisted man's race.

Invariably in any study involving "real world" data there will be instances of missing information. In particular, the fact that Education Level was absent for over one third of the individuals, made this variable of minimal value in the analysis. Additionally, about 1,200 values for GCT were missing. However, a visual perusal of the data on those individuals where GCT was not included revealed no particular trends or characteristics. Hence, it was assumed that the validity of any results based on the use of GCT was not affected by excluding those individuals whose GCT was missing.

The data lacked a comparison of a particular respondent's demographic variables and how he answered the questionnaire. Information of this type would be necessary if one desired an identification of trends in responses from specific strata of the respondent sub-sample. Reference 13 contains the percentage distribution of enlisted responses by rate, enlistment/extensions and marital status.

As noted previously, 24,900 questionnaires were mailed. The number of questionnaires returned to the Laboratory by the Post Office as undeliverable was 1,086 leaving 23,814. There were 16,645 questionnaires returned in all. Of that total 1,426 were returned after the cut-off date and the editing process claimed 1,468 leaving a balance of 13,751 as "true" respondents. The data indicated 13,684 respondents, thus 67 respondents were missing for the purposes of this study.

If one considers 16,645 of 23,814 as the return rate, then there were 7,169 "true" nonrespondents. Of course, 23,814 is a maximum estimate since there is no way of knowing just how many survey questionnaires did not reach the intended recipient. Unfortunately, during an earlier editing and compilation phase of the returns, the 1,426 returned after cut-off, 1,086 returned as undeliverable and 1,468 edited were all denoted as nonrespondents. Hence, the data should have included 7169 + 1425 + 1086 + 1468 = 11,149 as nonrespondents. However, only 10,461 were classified thusly, leaving a total of 688 missing.

Obviously, there was considerable comtamination of the data available for the nonrespondent population. Taking 16645/23814 = 0.699 as the response rate for the survey, then one would intuitively expect 0.699 x 1,086 ≐ 759 of the undeliverable questionnaires to have been returned. This being the case, then 1,426 + 1,468 + 759 = 3,653 who could have been classified as respondents were, in fact, included in with the nonrespondents. Hence, if there are any inherent differences between the populations one would expect that these differences would not be as readily apparent from the contaminated data since the characteristics of the nonrespondent population tend to approach those of the respondent population. That is, it is anticipated that any visible cleavage between the two sub-samples would be further polarized had the nonrespondent data not been biased.

V. ANALYSIS OF DEMOGRAPHIC VARIABLES

In any research endeavor when large amounts of data are present, it is often prudent to begin analysis by computing simple sample statistics and constructing frequency distributions. The first factor examined was age. The mean age for nonrespondents was calculated as 25.23 years and respondents were found to be slightly less than a year and a half older with a mean age of 26.77 years. The sample variances were 41.64 and 47.78 respectively. It should be noted though, that averages in this situation are not an especially representative statistic due to the skewed characteristic of the age distribution of service personnel. However, without prior knowledge of the form of that distribution it is possible with the aid of the Central Limit Theorem to assume a normal distribution for the sample means and perform a test of hypothesis concerning their equality.

Assuming the variances to be equal, the appropriate test statistic is

$$\frac{\bar{X}_1 - \bar{X}_2}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

where S_p^2 is the pooled estimate of the sample variances, $\bar{X}_1$ and $\bar{X}_2$ are the two sample means, and n_1 and n_2 are the respective sample sizes. The above statistic is distributed $t_{n_1+n_2-2}$, however, in the limit as the number of degrees of freedom becomes large, the t distribution approaches

the normal. Hence, with the value of the test statistic equal to -17.52 there was sufficient justification to reject the null hypothesis at the 5% level that the two means were equal.

Perhaps more informative than a comparison of mean ages is a frequency distribution of the ages. Table 1 lists the number of personnel that fall within six age categories. Included in parentheses is the corresponding percentage of the sample. It is then a simple matter to calculate the frequency of response within each age category for it is just the number responding divided by the sum of the respondents and nonrespondents in that category. From the inclusion of this information in the table, it is apparent that the likelihood of response increases with age to age 30 and remains constant thereafter. As a benchmark for comparison, the response rate considered herein will be 0.567 since the data utilized listed 13,684 respondents and 10,461 nonrespondents for a total of 24,145 cases (see Section IV).

	≤ 20	21-25	26-30	31-35	36-40	>40
RESPONDENT	1734(7.2)	6129(25.4)	2049(8.5)	1971(8.2)	1120(4.6)	681(2.8)
NON-RESPONDENT	1971(8.2)	5210(21.6)	1219(5.0)	1080(4.5)	608(2.5)	373(1.5)
Freq of Response	0.468	0.540	0.627	0.646	0.648	0.646

Table 1. Response vs. Age

Tables of the previous type can be very enlightening when one is confronted with a mass of data to be analyzed. It allows the researcher to systematically group and display the information in a manner in which obvious, and often subtle, differences are easily observable. It is for this reason that the remainder of this section is devoted to a display of

various 2 x n contingency tables reflecting response characteristics where n is the number of categories for a particular demographic variable. Appendix I contains the results of the Chi-Square Test for two independent samples for the above and succeeding tables in this section and for two tables from the next section. The hypothesis under test is that the two groups do not differ with respect to the demographic variable under consideration.

Table 2 contains the breakdown of response vs. GCT. The scores have the following interpretation [Ref. 2] :

65 and higher - "high" or about 7% of all enlisted personnel
55-64 - above average or about 24% of all enlisted personnel
45-54 - average or about 38% of all enlisted personnel
35-44 - below average or about 24% of all enlisted personnel
34 and below - "low" or about 7% of all enlisted personnel

	≥65	55-64	45-54	35-44	≤34
RESPONDENT	2089(8.7)	5212(21.6)	3782(15.7)	1568(6.5)	1033(4.3)
NON-RESPONDENT	1211(5.0)	3477(14.4)	3150(13.0)	1667(6.9)	956(4.0)
Freq. of Response	0.633	0.599	0.545	0.484	0.519

Table 2. Response vs. GCT Category

As a side note, it is apparent, at least from this sample, that today's Navymen are more intelligent than in the days when the original GCT distribution was devised. Almost twice the number of individuals comprised the 65 and higher group as compared to what the theoretical distribution had predicted. Likewise, in the above average group there were one-third more than expected. As a result, the next two groups were low but,

interestingly, the "low" group comprising 8.3% of the sample was quite close to the anticipated percentage.

With the exception of the "low" group, note the monotonically decreasing order of the frequencies of response for the GCT categories. As mentioned in Section IV, the fact that about one-third of the nonrespondents could actually be classified as respondents, it would be expected that under more ideal conditions not only would the frequencies be greater for the higher GCT classes but that monotonicity would be preserved, thus establishing an intuitively appealing relationship between GCT and response.

There are six categories under the Sea/Shore code: shore, sea overseas, toured sea duty (non-rotated ships), preferred sea, and preferred overseas. Table 3 contains a numerical breakdown for Sea/Shore code.

	Shore	Sea	Overseas	Toured Sea Duty	Preferred Sea Duty	Preferred Overseas
RESPONDENT	4862(20.1)	5904(24.5)	1243(5.1)	773(3.2)	275(1.1)	627(2.6)
NON-RESPONDENT	2984(12.4)	5159(21.4)	957(4.0)	869(3.6)	156(0.6)	336(1.4)
Freq. of Response	0.619	0.533	0.540	0.470	0.638	0.651

Table 3. Response vs. Sea/Shore Code

The greatest frequency of response was associated with the preferred overseas duty group. The next greatest were preferred sea and shore duty respectively. As might be expected, overseas duty and sea duty had lower response rates, while interestingly, those on toured sea duty responded at a rate of only 0.470.

Table 4 records response as a function of race. The response rates of 0.707 and 0.619 for Indian and Mongolian, respectively, should be taken with fairly low confidence due to the small sample sizes and the contamination that was present in the data.

	Caucasian	Negroid	Indian (Am)	Malayan	Mongolian
RESPONDENT	12,633(52.3)	567(3.2)	29(0.1)	429(1.8)	26(0.1)
NON-RESPONDENT	9,503(39.3)	613(2.5)	12(0.1)	317(1.3)	16(0.1)
Freq. of Response	0.570	0.480	0.707	0.575	0.619

Table 4. Response vs. Race

Table 5 contains the response characteristics when compared to the number of enlistments of a sample member.

	1	2	3	4	5 or more
RESPONDENT	7204(29.8)	2156(8.9)	2352(9.7)	1454(6.0)	518(2.1)
NON-RESPONDENT	6782(28.1)	1436(5.9)	1290(5.3)	734(3.0)	219(0.9)
Freq. of Response	0.515	0.600	0.645	0.664	0.618

Table 5. Response vs. Number of Enlistments

Of note here is that frequency of response increases with the number of enlistments until the fourth and then tapers off somewhat. Recall from Section III the study conducted by C. F. Reuss where a relationship was established between the response rate and loyalty to the originating agency. Similarly, the longer an individual remains in the Navy, as reflected by the number of enlistments, the greater are the ties that the individual

has for the Navy and, hence, the greater is the probability of response from that individual.

Finally, the last demographic variable considered in this series is the number of dependents. There are 18 categories under this heading: none, wife, wife and 1 child, ..., wife and 8 or more children, 1 dependent child, ..., 8 or more dependent children. Table 6 contains a condensa- of the results into 9 categories.

Dependency Status	Respondent	Nonrespondent	Frequency of Response
None	6097(25.3)	5846(24.2)	0.511
Wife	2254(9.3)	1646(6.8)	0.577
Wife & 1 child	1618(6.7)	1011(4.2)	0.615
Wife & 2 children	1614(6.7)	878(3.6)	0.647
" " 3 "	1081(4.5)	514(2.1)	0.677
" " 4 or more children	857(3.5)	456(1.9)	0.652
1 child	70(0.3)	52(0.2)	0.574
2 children	50(0.2)	36(0.1)	0.581
3 or more children	43(0.2)	22(0.1)	0.662

Table 6. Response vs. Dependency Status

VI. THE SUCCESS FACTOR

The primary objective of this study was to examine the premise that the more successful Navymen respond with a greater frequency than do those who are less successful. If this is the case and additionally it can be proven that an individual's responses differ as a function of his success-group membership, then the results will be biased in the direction of the proportionality of the group sizes. The first task in answering the above was to develop some criterion for success. Ultimately, what one would like for analyzing this situation would be a complete record of each individual's advancement-in-rate history. Then, all-Navy averages could be used as a comparison and an individual would be assigned an index which would signify his "rank," or success factor, within his peer (rate) group. The determination is then made that the more successful individuals advance more quickly, those of average success advance about at the rate of the all-Navy average, and the less successful obtain promotions at a slower rate.

Unfortunately, the data used for this study did not include such advancement history. An alternative, however, was to assume that, on the average, individuals enlist in the Navy at or near the same age. Then one need only compare an individual's age with his paygrade, or rate, to determine the individual's advancement, e.g., E-5 at age 23, E-7 at age 27, etc. What remains is some determination of how this compares with the other Navymen.

Before answering that question, the assumption of same age at first enlistment requires further consideration. Table 7 contains information on the age at enlistment for all the first-term (first enlistment) personnel from the sample population. Also included in that table for comparison is data [Ref. 14] which gives the percent enlisting at each age for Quarter IV-FY 70 (1 March - 30 June 1970).

AGE	NO.	PERCENT	ALL-NAVY QTR IV-FY 70 PERCENTAGES
17	643	4.60	8.00
18	3703	26.50	24.50
19	5147	36.80	24.30
20	2284	16.30	26.50
21	870	6.20	8.80
22	555	4.00	3.40
23	265	1.90	2.50
24	157	0.50	1.10
25	98	0.70	0.30
26	32	0.20	0.20
27	25	0.18	0.07
28	21	0.15	0.03
29	29	0.20	0.04
≥30	156	1.10	0.21
	13986		

Table 7. Frequency Distribution of Age at First Enlistment

The majority of the ages appear to be centered around age 19 in both cases. More precisely, the mean and the median of the distributions occur at 19 years. Therefore, if one had to choose an age which was most characteristic of the age at first enlistment, for the sample, 19 years would be the logical choice since almost 80% of the other ages fall within one year of it. It was felt that this was sufficient justification for assuming that, on the average, individuals enlist in the Navy at or near the same age.

The next step in assessing the success factor was to establish the criterion for success itself. This was accomplished by stratifying the sample by age (17, 18, ..., ≥50) and pay grade (E-1 through E-9) and displaying the number of personnel within each category in a 34x9 matrix. This was done for both the entire population and careerists alone (more than one enlistment). See Appendices A and B, respectively.

Each age-pay grade combination comprises a "cell" and there are 306 cells in all. Obviously, not all cells are non-empty since there is very little likelihood that a 19 or 20 year old has attained the pay grades of E-6 through E-9. Similarly, the chances are low that an individual of 35 years of age or older is an E-1 through E-3 unless, of course, as a result of disciplinary action.

The technique used for determining success is empirical in nature. It utilizes a notion appealed to by many statisticians; that is, data relating to human performance is in many ways very nearly normally distributed. The majority of the population falls in the average category which is within one standard deviation of the mean, while the above and below average people occupy the extremes of the normal "tails" to the right and left, respectively. Similarly, we can consider three categories of success: the more successful group, the average success group, and the less successful group.

To see how the empirical method for determining success works, refer to Table 8 which is a partial extract of the matrix from Appendix A.

	PAY GRADE				
AGE	E-1	E-2	E-3	E-4	E-5 ....
17	0	1	0	0	0
18	1	114	31	12	0
19	2	370	381	196	9
20	8	402	861	1140	177
21	4	148	663	1630	598
22	1	50	388	1827	1510
23	1	17	174	854	971
24	1	7	93	414	756
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

Table 8. Extract of Age-Pay Grade Matrix

The first step of the procedure is to scan each row, or age, and circle the largest number in that row as illustrated in Table 8. After the rows have been scanned the second step is to scan each column, or pay grade, and circle only the number immediately preceding and the number immediately following the number(s) previously circled from the row scan. Table 9 contains the results of steps 1 and 2.

	PAY GRADE				
AGE	E-1	E-2	E-3	E-4	E-5 ....
17	0	1	0	0	0
18	1	114	31	12	0
19	2	370	381	196	9
20	8	402	861	1140	177
21	4	148	663	1630	598
22	1	50	388	1827	1510
23	1	17	174	859	971
24	1	7	93	414	756
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

Table 9. Results of Applying Steps 1 and 2 of Empiric[illegible] Method

The final step is optional and consists of sketching a line (as illustrated in Table 9) around the circled items to further differentiate between the groups. The result is three distinct groups: the circled items representing the personnel of average success, and the groups to the right and left representing the more successful and less successful personnel, respectively. Since the technique is on the order of an "eyeball" routine, the procedures for grouping should not be particularly binding thus allowing the user to modify the circling steps when it appears there are one or more numbers especially close to the value of the largest in that row.

Admittedly in the case for all personnel the procedure created a particularly massive average group for the 17 through 20 and E-1 through E-5 cells. However, this feature can be considered desirable since the scheme's primary assumption was a common age at enlistment and a year or two difference at that age in the subordinate pay grades could lead to considerable classification errors. Note, though, that as age increases this year or two difference becomes relatively less critical and the technique approaches "stability" with more or less balanced ratios in each success group. It is better to be on the conservative side when the procedure is particularly susceptible to error.

Appendices C and D contain the completed success classification groupings for all personnel and careerists, respectively.

The next step in analyzing the success factor was to construct matrices similar to those in Appendices A and B, but instead of totals the elements were composed of the frequencies of response for each cell

(i.e., the number of respondents in the cell divided by the total number of personnel in the cell). Appendices E and F contain the desired response rates. Note the asterisks designate an empty cell to differentiate it from a cell with a true zero response rate.

As might be expected, the final phase of this process was to obtain the composite response rates for each success group. Tables 10 and 11 contain the results for the entire population and careerists, respectively.

	RESPONDENTS	NONRESPONDENTS	TOTAL	RESPONSE RATE
MORE SUCCESSFUL	1989	922	2911	0.684
AVERAGE SUCCESS	9480	7071	16551	0.573
LESS SUCCESSFUL	2215	2468	4683	0.473

Table 10. Response Rates of Success Groups for All Personnel

	RESPONDENTS	NONRESPONDENTS	TOTAL	RESPONSE RATE
MORE SUCCESSFUL	1462	523	1985	0.737
AVERAGE SUCCESS	4037	2229	6266	0.644
LESS SUCCESSFUL	981	927	1908	0.514

Table 11. Response Rates of Success Groups for Careerists

In Section V we observed that personnel with more than one enlistment responded more frequently than did first-term personnel, so the higher response rates for careerists in Table 11 were expected. The above results clearly indicate that there exists reasonable evidence to support the claim that successful personnel respond more frequently than do those who are not as successful.

VII. FURTHER CONSIDERATIONS

To analyze the success factor the previous section dealt with a two-way stratification of the survey sample on the basis of age and pay grade. It was decided to extend this concept by including an additional dimension of stratification -- the general classification test score (GCT).

As noted in Section V, there are five GCT categories. For economy and ease of display the low and below average categories were condensed into a low group, and similarly, the high and above average categories comprise the high group. Appendix G contains the frequency distributions resulting from this three-way stratification for all personnel.

Table 12 contains a numerical analysis for the number of personnel within each category and the corresponding response rates.

SUCCESS GROUP	GCT	RESPONDENTS	NONRESPONDENTS	TOTAL	RESPONSE RATE
MORE SUCCESSFUL	LOW	123	79	202	0.609
	AVERAGE	1408	653	2061	0.683
	HIGH	376	154	530	0.709
AVERAGE	LOW	1094	1124	2218	0.493
	AVERAGE	6455	4743	11198	0.576
	HIGH	1461	877	2338	0.625
LESS SUCCESSFUL	LOW	654	864	1518	0.431
	AVERAGE	1131	1231	2362	0.479
	HIGH	252	180	432	0.583

Table 12. Response Rates Resulting from Age-Pay Grade-GCT Stratification

The results of Table 12 indicate that there exists a more than casual relationship between GCT and success category, as might be expected. Note that the response rates exhibit a symmetric-like nature between and

within success groups. Especially appealing in these results is the fact that the greatest response rate, 0.709, is associated with the high GCT-successful group, while the smallest response rate, 0.431, is from the low GCT-less successful group.

Having obtained some interesting results with GCT, it was decided to consider an individual's occupational specialty or rate code instead of GCT as another alternative for the third dimension of stratification.

BUPERS Report 1080-14 contains the 5-character alpha/numeric equivalency of the rating abbreviations which is used for data processing purposes, (e.g., GM3=02004, GMGC=06041, YNSN=17005, MMCS=37001). The 1080-14 also contains a convenient grouping of the ratings into 12 categories of similarly skilled ratings. Appendix H lists the 12 groups and their respective ratings. Table 13 contains a condensation of the results from this stratification scheme.

	RESPONSE RATE FOR				
GROUP	TOTAL	MORE SUCCESSFUL	AVERAGE	LESS SUCCESSFUL	AGGREGATE GROUP RESPONSE RATE
I	1652	0.726	0.587	0.543	0.599
II	1915	0.705	0.593	0.532	0.601
III	545	0.698	0.703	0.571	0.692
IV	67	0.769	0.622	0.444	0.627
V	4702	0.657	0.580	0.486	0.573
VI	1396	0.800	0.475	0.407	0.442
VII	3204	0.706	0.580	0.392	0.564
VIII	2036	0.388	0.339	0.302	0.337
IX	5965	0.707	0.615	0.532	0.612
X	2093	0.784	0.624	0.528	0.634
XI	104	0.857	0.653	0.480	0.625
XII	466	0.857	0.670	0.566	0.592

Table 13. Results from Age-Pay Grade-Rating Stratification

The relatively low frequency of response from Group VI is understandable since it is composed predominately of Seaman and Seaman Apprentice, personnel usually in the first enlistment. Recall from Table 5 that the overall frequency of response for all first-term personnel was 0.515, the lowest for the five categories considered. Of particular interest, however, was the 0.337 response rate associated with Group VIII (construction), lowest of all 12 groups. The information at hand lacked an explanation for the reason behind this unusually low response rate. However, recall from Section III the results of the survey conducted on milk producers in North Carolina. The feeling of the survey originators was that the amount of work required to fill out the questionnaire increased and the amount of available free time decreased as the scale of operations increases. It would be interesting to see a comparison of the work loads of the construction ratings as compared to some of the other ratings in the Navy.

As a final consideration in the analysis of the NPS 69-1 demographic data the effect of time remaining in the Navy and motivation to respond to the survey was examined. First-term personnel with an EAOS date of between 6 months and one year from the survey date responded at the rate of 0.465. Those with 3 to 6 months before release date had a frequency of response of 0.492, and those who had less than 3 months remaining responded at the rate of 0.479. Hence, the response rate remained more or less constant as the time until release from active duty decreased.

VIII. MEASURING BIAS IN MAIL SURVEYS

In general, sampling errors are those errors attributed to the fact that only a portion of the universe is selected for study, instead of every unit as is done in a complete census. All errors other than sampling errors are called nonsampling errors. Included in this nonsampling category are errors made by respondents in reporting data, errors made by interviewers in recording data, computational errors made in processing the data and, in particular, nonresponse in mail surveys. It is possible that some of these errors may be compensating and average out. However, many of them are not random in nature and they may well lead to detrimental biases in the final results.

Attempting to completely eliminate the nonsampling errors from a mail survey would incur such prohibitive costs that the technique would lose one of its principal features -- economy. Perhaps a more realistic approach is to eliminate as many of the nonsampling errors as possible and measure the effects of the remainder.

Although a survey may involve tireless efforts by the originators in designing the questionnaire and drawing a valid sample from the population to be surveyed, the return seldom approaches 100 percent completeness. Various devices for dealing with the bias caused by nonresponse have been described in the literature. Two, in particular, will be discussed here for their applicability to the NPS series. They are observation of trends

in data from repeated mailings and a cost trade-off model for double sampling.

The procedure of observing trends from repeated mailings is a particularly useful device for learning something about the nonrespondents in a mail survey (recall from Section III the case of the North Carolina fruit growers). As a hypothetical example, suppose one of the objectives of a questionnaire is to find the percentage of personnel in favor of a new policy, say, a uniform change for enlisted personnel.

From a mailing list of 5,000 the first wave yielded 2,000 returns, representing 40 percent of the total. A second request to the remainder of the list yielded 1,000 returns, representing 20 percent of the original total list. The third and last request, sent to the individuals who still had not responded, yielded 500 returns, representing 10 percent of the original list. The results are shown in Table 14. The percentage of individuals desiring the uniform change refers only to those who responded to that particular request.

Mailing	Returned Questionnaires Number	Percent	Percent Desiring Uniform Change
1	2000	40	78
2	1000	20	61
3	500	10	47

Table 14. Results of Hypothetical Survey on Uniform Change

Table 14 indicates that the portion of individuals desiring the uniform change in each wave of returns becomes progressively smaller. An

examination of the cumulative results in Table 15 indicates that using just the returns from the first mailing would have overestimated the desirability for a uniform change obtained from the 3 mailings by about 10 percent.

Mailing	Percent Return	% in Favor
1	40	78
1+2	60	72.3
1+2+3	70	68.7

Table 15. Cumulative Results from Hypothetical Survey

However, 68.7 percent is not necessarily the true portion of those in favor. If the trend can be extrapolated, it should be possible to estimate the percent in favor of the change corresponding to a cumulative return of 100 percent. Figure 1 depicts a rough graphical solution to the regression problem (the graphical solution was used for illustrative purposes only--analytical techniques are recommended in actual practice.) In this example the percent in favor of the change corresponding to a 100 percent return would be about 55 percent.

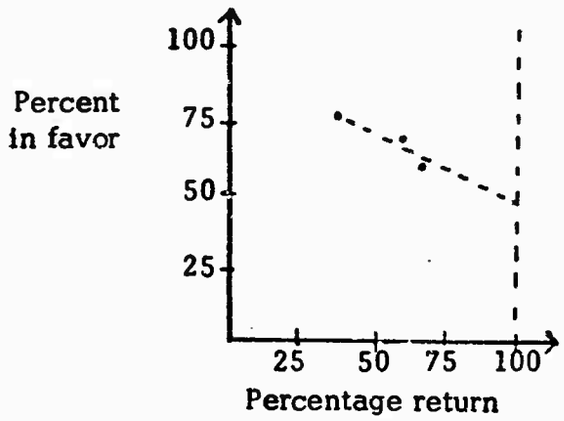

Figure 1.

A word of caution, however. The literature on regression analysis is careful to warn the reader on the hazards of extrapolating the regression curve "sufficiently" beyond the range of data for which it was constructed. Nevertheless, one could use 55 percent as a lower bound and consider 68.7 percent as the upper bound. Then the estimate of the percent in favor of the change corresponding to a 100 percent return would fall somewhere in between those values. At this point it would be nice to have some analytical procedure to establish the standard $1-\alpha$ percent confidence interval for the range of values. To this writer's knowledge, however, no such procedures presently exist.

Another approach in dealing with nonresponse involves the use of double sampling where a sample of the nonrespondents are actually interviewed. The problem is to determine the number of mail questionnaires to be sent out and the number of personal interviews to conduct in following up nonresponse to the mail questionnaire in order to attain the required precision at a minimum cost. The precision referred to is the maximum tolerable standard error of the estimate of the variable or characteristic under consideration.

Assume that the cost equation is given by [12]

$$C = C_o n + C_1 n_1 + C_2 n_2$$

where C_o = cost per questionnaire of mailing

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[12] Hansen, M.H., Hurwitz, W.N., and Madow, W.G., Sample Survey Methods and Theory, vol. 1, p. 474, John Wiley and Sons, Inc., 1953.

C_1 = cost per questionnaire of processing returned questionnaires

C_2 = cost per questionnaire for interview and processing

n = number of questionnaires sent out

n_1 = number of respondents

$n_2 = (1/k)n_3$ = number of interviews to be conducted where n_3 is the number of nonrespondents

According to the principle of optimum allocation, it can be shown that the optimum values for n and k can be computed from the following formulas[13]:

$$n = \frac{N^2 S^2}{E^2 + NS^2} \left[1 + (k-1)P_2\right]$$

$$k = \left[\frac{C_2 P_1}{C_o + C_1 P_1}\right]^{\frac{1}{2}}$$

where N = size of population to be sampled

S^2 = variance estimate of variable under consideration

P_2 = rate of nonresponse to mailed questionnaire

$P_1 = 1 - P_2$

E = standard error to be tolerated of the variable

Note, the results obtained above assume that the variances of responses for both respondents and nonrespondents are equal. This is usually done in practice since an a priori knowledge of these values is

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[13]The proof is given in Vol. II, Ch. 11, Sec. 5 of ref. 7.

difficult to estimate. Also, a response rate, P_1, must be supplied before the optimum n and k can be computed. This can usually be estimated with a fair degree of accuracy from results of similar previous surveys. Having thus solved for n and k, the number of interviews to be conducted is then given by n_3/k.

IX. SUMMARY AND CONCLUSIONS

In this paper data consisting of demographic variables on the enlisted personnel participating in the 1969 Navy Personnel Survey was analyzed to determine if differences exist between those who responded to the survey and those who did not respond. In particular, the claim that the more successful Navymen respond with a greater frequency than do those who are less successful was examined. An empirical classification scheme for determination of success was presented. The scheme stratified the survey population according to age and pay grade. The addition of GCT score and rating as third dimensions of stratification was also considered. Additionally, two procedures for measuring bias in mail surveys were discussed.

In conclusion then, this paper has attempted to identify those demographic variables that were correlated with frequency of response. Of the six variables considered in Section V, all when viewed separately were found to be characteristics on which the respondents and nonrespondents differed significantly. Specifically, an individual's age, general classification test score, type of duty, race, number of enlistments, and dependency status were all factors that influenced the response rate.

The success of an individual was determined to be another variable affecting the frequency of response. Three classes of success were considered: more successful, average success, and less successful. The analysis indicated that the respondents and nonrespondents differed

significantly with respect to success classification. In particular, the response rate increased with a corresponding increase in the degree of success.

APPENDIX A

AGE-PAY GRADE FREQUENCY DISTRIBUTION FOR ALL PERSONNEL

AGE	PAY GRADE								
	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
17	0	1	0	0	0	0	0	0	0
18	1	114	31	12	0	C	0	0	0
19	2	370	381	196	9	0	0	C	C
20	8	402	861	1140	177	0	0	0	0
21	4	148	663	1630	598	2	0	0	0
22	1	50	388	1827	151C	37	0	0	0
23	1	17	174	855	971	78	0	0	0
24	1	7	93	414	756	153	0	0	0
25	0	4	37	189	498	227	2	0	0
26	0	0	27	111	433	324	9	0	0
27	C	0	20	66	238	315	26	0	0
28	1	1	14	31	179	274	47	C	0
29	1	1	5	24	138	315	71	0	0
30	0	0	11	17	121	333	108	7	0
31	0	0	10	20	137	391	186	13	1
32	0	C	3	17	122	330	175	17	4
33	0	0	4	21	97	245	174	13	2
34	0	C	2	12	84	225	173	28	7
35	C	0	0	13	77	234	169	40	5
36	0	0	0	8	58	175	156	37	9
37	0	C	0	11	59	123	144	48	8
38	0	0	0	8	36	112	122	46	21
39	0	0	0	7	28	103	108	46	13
40	0	0	1	2	21	61	102	38	17
41	0	0	0	2	16	50	75	18	8
42	0	C	0	1	15	53	55	31	10
43	0	0	1	6	17	44	55	19	16
44	0	0	0	2	14	35	55	20	9
45	0	0	0	1	3	20	48	21	18
46	0	0	0	2	3	17	24	18	7
47	0	0	0	0	6	9	23	10	9
48	0	0	0	1	5	7	18	20	3
49	0	0	0	0	3	3	19	5	5
≥ 50	0	C	0	1	3	17	40	24	14

APPENDIX B

AGE-PAY GRADE FREQUENCY DISTRIBUTION FOR CAREERISTS

AGE	PAY GRADE								
	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
17	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0
20	0	0	0	10	11	0	0	0	0
21	0	0	2	55	60	1	0	0	0
22	0	3	5	85	208	26	0	0	0
23	0	1	8	66	219	57	0	0	0
24	0	0	5	57	247	129	0	0	0
25	0	1	5	53	257	192	2	0	0
26	0	0	7	46	268	307	9	0	0
27	0	0	6	38	187	297	26	0	0
28	1	1	2	21	143	268	47	0	0
29	1	1	2	18	128	298	70	0	0
30	0	0	3	14	107	323	108	7	0
31	0	0	7	17	123	387	181	13	1
32	0	0	3	16	115	325	174	17	4
33	0	0	3	17	92	241	173	13	2
34	0	0	1	10	75	221	169	28	7
35	0	0	0	10	72	222	168	40	5
36	0	0	0	8	54	171	154	37	9
37	0	0	0	11	54	117	143	48	8
38	0	0	0	7	30	106	120	46	21
39	0	0	0	4	26	100	107	45	13
40	0	0	1	2	19	57	101	38	17
41	0	0	0	2	13	45	74	18	8
42	0	0	0	1	15	51	53	31	10
43	0	0	1	6	16	42	53	19	16
44	0	0	0	1	14	33	55	20	9
45	0	0	0	1	3	18	46	21	18
46	0	0	0	2	3	14	23	18	7
47	0	0	0	0	6	9	20	10	9
48	0	0	0	1	5	7	18	20	3
49	0	0	0	0	2	3	18	5	5
≥ 50	0	0	0	0	3	15	37	24	14

APPENDIX C

SUCCESS CLASSIFICATIONS FOR ALL PERSONNEL

AGE	PAY GRADE								
	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
17	C	1	0	0	0	0	0	0	0
18	1	114	31	12	0	0	0	0	0
19	2	370	381	196	9	0	0	0	C
20	8	402	861	1140	177	0	0	0	0
21	4	148	663	1630	598	2	0	0	C
22	1	50	388	1827	1510	37	0	0	0
23	1	17	174	859	971	78	0	0	0
24	1	7	93	414	756	153	0	C	0
25	0	4	37	189	498	227	2	0	0
26	0	0	27	111	433	324	9	0	0
27	0	0	20	66	238	315	26	0	0
28	1	1	14	31	179	274	47	0	0
29	1	1	5	24	138	315	71	0	0
30	0	0	11	17	121	333	108	7	0
31	0	0	10	20	137	391	186	13	1
32	0	C	3	17	122	330	175	17	4
33	C	0	4	21	97	245	174	13	2
34	0	0	2	12	84	225	173	28	7
35	0	0	0	13	77	234	169	40	5
36	0	0	0	8	58	175	156	37	9
37	0	0	0	11	59	123	144	48	8
38	C	0	0	8	36	112	122	46	21
39	0	0	0	7	28	103	108	46	13
40	C	C	1	2	21	61	102	38	17
41	0	0	0	2	16	50	75	18	8
42	0	0	0	1	15	53	55	31	10
43	0	0	1	6	17	44	55	19	16
44	0	0	0	2	14	35	55	20	9
45	0	0	0	1	3	20	48	21	18
46	C	0	0	2	3	17	24	18	7
47	0	C	0	0	6	9	23	10	9
48	C	0	0	1	5	7	18	20	3
49	C	0	0	0	3	3	19	5	5
≥ 50	0	0	0	1	3	17	40	24	14

LESS SUCCESSFUL — AVERAGE SUCCESS — MORE SUCCESSFUL

APPENDIX D

SUCCESS CLASSIFICATIONS FOR CAREERISTS

AGE	PAY GRADE								
	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
17	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0
20	0	0	0	10	11	0	0	0	0
21	0	0	2	55	60	1	0	0	0
22	0	3	5	85	208	26	0	0	0
23	0	1	8	66	219	57	0	0	0
24	0	0	5	57	247	129	0	0	0
25	0	1	5	53	257	192	2	0	0
26	0	0	7	46	268	307	9	0	0
27	0	0	6	38	187	297	26	0	0
28	1	1	2	21	143	268	47	0	0
29	1	1	2	18	128	298	70	0	0
30	0	0	3	14	107	323	108	7	0
31	0	0	7	17	123	387	181	13	1
32	0	0	3	16	115	325	174	17	4
33	0	0	3	17	92	241	173	13	2
34	0	0	1	10	75	221	169	28	7
35	0	0	0	10	72	222	168	40	5
36	0	0	0	8	54	171	154	37	9
37	0	0	0	11	54	117	143	48	8
38	0	0	0	7	30	106	120	46	21
39	0	0	0	4	26	100	107	45	13
40	0	0	1	2	19	57	101	38	17
41	0	0	0	2	13	45	74	18	8
42	0	0	0	1	15	51	53	31	10
43	0	0	1	6	16	42	53	19	16
44	0	0	0	1	14	33	55	20	9
45	0	0	0	1	3	18	46	21	18
46	0	0	0	2	3	14	23	18	7
47	0	0	0	0	6	9	20	10	9
48	0	0	0	1	5	7	18	20	3
49	0	0	0	0	2	3	18	5	5
≥50	0	0	0	0	3	15	37	24	14

LESS SUCCESSFUL — AVERAGE SUCCESS — MORE SUCCESSFUL

APPENDIX E
RESPONSE RATES FROM AGE-PAY GRADE STRATIFICATION FOR ALL PERSONNEL

AGE	PAY GRADE								
	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
17	*****	1.000	*****	*****	*****	*****	*****	*****	*****
18	0.0	0.421	C.484	0.417	*****	*****	*****	*****	*****
19	C.500	C.392	C.449	0.464	0.333	*****	*****	*****	*****
20	0.625	0.388	0.458	0.530	0.537	*****	*****	*****	*****
21	0.250	0.365	C.410	0.522	C.569	C.500	*****	*****	*****
22	0.0	0.340	0.461	0.514	0.562	0.703	*****	*****	*****
23	0.0	0.412	0.460	C.540	C.598	0.705	*****	*****	*****
24	0.C	0.0	C.462	0.514	0.628	0.667	*****	*****	*****
25	*****	0.250	0.351	0.513	0.618	0.705	1.000	*****	*****
26	*****	*****	0.593	0.486	0.607	0.66C	0.667	*****	*****
27	*****	*****	C.500	0.500	0.563	0.667	0.808	*****	*****
28	0.0	1.000	0.786	0.452	0.559	0.730	C.787	*****	*****
29	1.000	0.0	C.200	0.500	C.551	0.619	0.775	*****	*****
30	*****	*****	0.545	0.647	0.537	0.649	0.750	0.857	*****
31	*****	*****	0.300	0.450	0.562	0.696	C.683	0.846	1.000
32	*****	*****	C.0	0.529	0.475	0.661	0.743	0.824	1.000
33	*****	*****	0.250	0.571	0.464	0.612	0.747	C.846	1.000
34	*****	*****	C.500	0.750	0.452	C.591	0.699	C.786	0.571
35	*****	*****	*****	0.385	0.571	0.641	0.740	C.750	1.000
36	*****	*****	*****	0.375	0.569	0.640	0.718	0.811	0.667
37	*****	*****	*****	0.455	0.542	C.602	0.694	0.708	0.875
38	*****	*****	*****	0.375	0.444	0.607	0.770	0.761	0.762
39	*****	*****	*****	0.286	C.571	0.534	C.667	0.761	C.769
40	*****	*****	C.0	1.000	0.476	0.541	0.696	0.632	0.588
41	*****	*****	*****	0.500	C.438	0.440	0.667	C.667	C.750
42	*****	*****	*****	1.000	0.600	0.509	C.764	0.742	0.500
43	*****	*****	1.000	0.667	0.412	0.614	0.691	1.000	0.688
44	*****	*****	*****	0.C	0.286	0.486	C.709	C.850	C.889
45	*****	*****	*****	0.C	0.667	0.700	0.667	0.810	0.778
46	*****	*****	*****	0.500	0.667	0.705	0.792	C.778	C.857
47	*****	*****	*****	*****	0.167	0.556	0.783	0.600	0.444
48	*****	*****	*****	0.0	0.400	0.286	0.667	0.750	1.000
49	*****	*****	*****	*****	0.C	0.333	0.632	C.600	C.800
≥ 50	*****	*****	*****	0.C	0.0	0.412	C.65	0.750	0.857

APPENDIX F

RESPONSE RATES FROM AGE-PAY GRADE STRATIFICATION FOR CAREERISTS

AGE	PAY GRADE								
	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
17	*****	*****	*****	*****	*****	*****	*****	*****	*****
18	*****	*****	*****	*****	*****	*****	*****	*****	*****
19	*****	*****	*****	*****	*****	*****	*****	*****	*****
20	*****	*****	*****	0.200	0.364	*****	*****	*****	*****
21	*****	*****	0.500	0.618	0.600	0.C	*****	*****	*****
22	*****	0.667	0.400	0.435	C.558	C.731	*****	*****	*****
23	*****	0.0	0.250	0.424	0.621	0.684	*****	*****	*****
24	*****	*****	0.400	0.404	C.628	0.651	*****	*****	*****
25	*****	0.0	C.200	0.491	0.595	0.693	1.000	*****	*****
26	*****	*****	0.571	0.413	0.642	0.668	0.667	*****	*****
27	*****	*****	C.500	C.500	C.551	C.663	0.808	*****	*****
28	C.0	1.000	1.000	0.429	0.573	0.731	0.787	*****	*****
29	1.000	0.0	0.0	0.556	C.547	0.611	0.771	*****	*****
30	*****	*****	1.000	0.643	0.533	C.65C	0.750	0.857	*****
31	*****	*****	0.143	0.471	0.593	0.698	0.680	0.846	1.CCC
32	*****	*****	C.0	0.563	0.461	C.665	C.747	C.824	1.000
33	*****	*****	C.0	0.529	0.467	C.614	0.751	0.846	1.000
34	*****	*****	1.000	C.700	0.453	C.588	0.704	C.786	0.571
35	*****	*****	*****	0.400	C.611	0.653	0.744	0.750	1.000
36	*****	*****	*****	0.375	C.556	C.632	0.727	C.811	0.667
37	*****	*****	*****	0.455	C.574	C.598	C.692	0.708	0.875
38	*****	*****	*****	0.429	0.467	0.632	0.775	0.761	0.762
39	*****	*****	*****	0.500	0.577	0.540	C.664	0.778	0.769
40	*****	*****	C.0	1.000	0.474	0.544	0.703	0.632	0.588
41	*****	*****	*****	0.500	0.385	0.444	0.662	0.667	0.750
42	*****	*****	*****	1.000	0.600	C.529	C.755	C.742	C.500
43	*****	*****	1.000	0.667	0.375	0.595	0.698	1.000	0.688
44	*****	*****	*****	0.0	0.286	0.485	0.709	C.850	C.889
45	*****	*****	*****	0.C	0.667	0.667	0.674	0.81C	0.778
46	*****	*****	*****	0.500	0.667	0.714	0.783	C.778	0.857
47	*****	*****	*****	*****	0.167	0.556	C.850	C.6CC	0.444
48	*****	*****	*****	0.C	0.400	0.286	0.667	0.750	1.000
49	*****	*****	*****	*****	0.C	0.333	0.667	C.6CC	0.8CC
≥50	*****	*****	*****	*****	0.0	C.400	C.7C	C.75C	0.857

APPENDIX G

AGE-PAY GRADE-GCT FREQUENCY DISTRIBUTION FOR ALL PERSONNEL

AGE	GCT	PAY GRADE							
		E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8
17	LOW	0	0	0	0	0	0	0	0
17	AVG	0	1	0	0	0	0	0	0
17	HIGH	0	0	0	0	0	0	0	0
18	LOW	1	24	4	3	0	0	0	0
18	AVG	0	63	14	7	0	0	0	0
18	HIGH	0	6	7	2	0	0	0	0
19	LOW	0	81	38	21	0	0	0	0
19	AVG	1	205	274	145	8	0	0	0
19	HIGH	0	31	34	24	1	0	0	0
20	LOW	2	120	152	106	8	0	0	0
20	AVG	1	197	576	839	132	0	0	0
20	HIGH	2	37	101	171	33	0	0	0
21	LOW	1	59	123	138	26	0	0	0
21	AVG	3	67	431	1217	409	1	0	0
21	HIGH	0	16	77	234	133	1	0	0
22	LOW	0	17	101	200	102	0	0	0
22	AVG	1	26	210	1284	1057	28	0	0
22	HIGH	0	3	58	272	298	7	0	0
23	LOW	0	6	54	130	60	4	0	0
23	AVG	1	9	72	530	628	54	0	0
23	HIGH	0	1	30	158	231	15	0	0
24	LOW	0	2	27	70	74	8	0	0
24	AVG	1	2	42	248	468	101	0	0
24	HIGH	0	0	17	63	170	27	0	0
25	LOW	0	2	12	41	64	17	0	0
25	AVG	0	1	18	95	304	151	2	0
25	HIGH	0	0	5	34	103	39	0	0
26	LOW	0	0	16	27	68	27	0	0
26	AVG	0	0	8	51	245	223	6	0
26	HIGH	0	0	0	20	74	56	3	0
27	LOW	0	0	15	22	43	28	0	0
27	AVG	0	0	3	32	144	222	14	0
27	HIGH	0	0	0	4	30	44	12	0
28	LOW	0	1	7	16	44	31	3	0
28	AVG	1	0	6	9	100	197	32	0
28	HIGH	0	0	1	1	15	32	10	0
29	LOW	0	0	5	13	31	39	6	0
29	AVG	1	1	0	8	80	233	51	0
29	HIGH	0	0	0	0	8	23	11	0
30	LOW	0	0	6	7	38	46	6	0
30	AVG	0	0	4	8	61	243	85	6
30	HIGH	0	0	0	2	5	23	14	1
31	LOW	0	0	8	12	64	89	22	0
31	AVG	0	0	2	5	58	266	138	8
31	HIGH	0	0	0	2	4	19	20	5
32	LOW	0	0	3	10	58	86	20	0
32	AVG	0	0	0	6	48	211	133	12
32	HIGH	0	0	0	1	3	16	16	5
33	LOW	0	0	3	13	49	63	22	0
33	AVG	0	0	1	5	38	165	12[illegible]	9
33	HIGH	0	0	0	0	0	6	1[illegible]	3

APPENDIX G (CONT'D)

34	LOW	0	0	2	9	49	88	22	0
34	AVG	0	0	0	3	29	118	132	21
34	HIGH	0	0	0	0	1	10	16	7
35	LOW	0	0	0	10	37	80	24	3
35	AVG	0	0	0	3	33	132	127	30
35	HIGH	0	0	0	0	1	8	15	7
36	LOW	0	0	0	5	30	59	25	2
36	AVG	0	0	0	2	21	101	117	29
36	HIGH	0	0	0	1	1	8	11	3
37	LOW	0	0	0	8	28	40	27	5
37	AVG	0	0	0	2	24	75	99	36
37	HIGH	0	0	0	0	0	3	17	7
38	LOW	0	0	0	7	21	37	17	1
38	AVG	0	0	0	0	13	63	94	37
38	HIGH	0	0	0	0	0	7	10	7
39	LOW	0	0	0	4	13	26	13	3
39	AVG	0	0	0	2	12	69	83	30
39	HIGH	0	0	0	0	1	4	10	11
40	LOW	0	0	1	1	11	25	13	4
40	AVG	0	0	0	1	9	32	78	27
40	HIGH	0	0	0	0	0	3	10	6
41	LOW	0	0	0	2	6	17	13	0
41	AVG	0	0	0	0	7	27	53	16
41	HIGH	0	0	0	0	1	2	9	2
42	LOW	0	0	0	1	5	20	8	4
42	AVG	0	0	0	0	8	24	44	21
42	HIGH	0	0	0	0	2	6	1	6
43	LOW	0	0	1	5	9	10	7	1
43	AVG	0	0	0	0	6	32	43	12
43	HIGH	0	0	0	0	0	0	3	5
44	LOW	0	0	0	1	8	6	11	1
44	AVG	0	0	0	1	4	27	32	13
44	HIGH	0	0	0	0	1	0	9	6
45	LOW	0	0	0	1	2	6	14	2
45	AVG	0	0	0	0	1	10	24	14
45	HIGH	0	0	0	0	0	1	6	5
46	LOW	0	0	0	2	2	4	2	3
46	AVG	0	0	0	0	1	9	17	12
46	HIGH	0	0	0	0	0	2	2	3
47	LOW	0	0	0	0	3	5	3	0
47	AVG	0	0	0	0	3	3	13	9
47	HIGH	0	0	0	0	0	0	5	0
48	LOW	0	0	0	1	3	2	5	2
48	AVG	0	0	0	0	2	5	12	13
48	HIGH	0	0	0	0	0	0	1	5
49	LOW	0	0	0	0	2	0	2	1
49	AVG	0	0	0	0	1	2	14	3
49	HIGH	0	0	0	0	0	0	2	1
≥ 50	LOW	0	0	0	1	2	5	4	2
≥ 50	AVG	0	0	0	0	0	9	26	17
≥ 50	HIGH	0	0	0	0	1	3	9	5

APPENDIX H

GROUPING OF NAVAL ENLISTED RATINGS

GROUP I (DECK)

BM	BOATSWAIN MATE
QM	QUARTERMASTER
SM	SIGNALMAN
RD	RADARMAN
ST	SONAR TECHNICIAN
STG	(SURFACE)
STS	(SUBMARINES)
OT	OCEAN SYSTEMS TECHNICIAN

GROUP II (ORDNANCE)

TM	TORPEDOMAN'S MATE
GM	GUNNER'S MATE
GMM	(MISSILES)
GMT	(TECHNICIANS)
GMG	(GUNS)
FT	FIRE CONTROL TECHNICIAN
FTG	(GUN FIRE CONTROL)
FTM	(SURFACE MISSILE FIRE CONTROL)
FTB	(BALLISTIC MISSILE FIRE CONTROL)
MT	MISSILE TECHNICIAN
MN	MINEMAN

GROUP III (ELECTRONICS)

ET	ELECTRONICS TECHNICIAN
ETN	(COMMUNICATIONS)
ETR	(RADAR)
DS	DATA SYSTEMS TECHNICIAN

GROUP IV (PRECISION EQUIPMENT)

PI	PRECISION INSTRUMENTMAN
IM	INSTRUMENTMAN
OM	OPTICALMAN

GROUP V (ADMINISTRATION AND CLERICAL)

RM	RADIOMAN
CT	COMMUNICATIONS TECHNICIAN
YN	YEOMAN
CYN	COMMUNICATIONS YEOMAN
PN	PERSONNELMAN
DP	DATA PROCESSING TECHNICIAN
SK	STOREKEEPER
DK	DISBURSING CLERK
CS	COMMISSARYMAN
SH	SHIPS SERVICEMAN
JO	JOURNALIST
PC	POSTAL CLERK

GROUP VI (MISCELLANEOUS)

LI	LITHOGRAPHER
DM	DRAFTSMAN
MU	MUSICIAN
SN	SEAMAN
SA	SEAMAN APPRENTICE
SR	SEAMAN RECRUIT

APPENDIX H (CON'T)

GROUP VII (ENGINEERING AND HULL)

MM	MACHINIST'S MATE	SF	SHIPFITTER
EN	ENGINEMAN	DC	DAMAGE CONTROLMAN
MR	MACHINERY REPAIRMAN	PM	PATTERN MAKER
BT	BOILERMAN	ML	MOLDER
BR	BOILERMAKER	FN	FIREMAN
EM	ELECTRICIAN'S MATE	FA	FIREMAN APPRENTICE
IC	INTERIOR COMMUNICATIONS ELECTRICIAN	FR	FIREMAN RECRUIT

GROUP VIII (CONSTRUCTION)

CU	CONSTRUCTIONMAN	BU	BUILDER
EA	ENGINEERING AID	SW	STEELWORKER
CE	CONSTRUCTION ENGINEER	UT	UTILITIESMAN
		CN	CONSTRUCTION MAN
EQ	EQUIPMENTMAN	CA	CONSTRUCTION APPRENTICE
EO	EQUIPMENT OPERATOR	CR	CONSTRUCTION RECRUIT
CM	CONSTRUCTION MECHANIC		

GROUP IX (AVIATION)

AF	AIRCRAFT MAINTENANCE	AB	AVIATION BOATSWAIN'S MATE
AV	AVIONICS TECHNICIAN	AE	AVIATION ELECTRICIAN'S MATE
AD	AVIATION MACHINIST MATE	AM	AVIATION STRUCTURAL MECHANIC
		PR	AIRCREW SURVIVAL EQUIPMENTMAN
ADR	(RECIPROCATING ENGINE MECHANIC)	AG	AEROGRAPHER'S MATE
		TD	TRADEVMAN
ADJ	(JET ENGINE MECHANIC)	AK	AVIATION STOREKEEPER
AT	AVIATION ELECTRONICS TECHNICIAN	AZ	AVIATION MAINTENANCE ADMIN MAN
ATR	(RADAR AND RADAR NAV EQUIPMENT)	AS	SUPPORT EQUIPMENT TECHNICIAN
		PH	PHOTOGRAPHER'S MATE
ATN	(RADIO AND RADIO NAV EQUIPMENT)	PT	PHOTOGRAPHIC INTELLIGENCEMAN
		AN	AIRMAN
AX	AVIATION ASW TECHNICIAN	AA	AIRMAN APPRENTICE
		AR	AIRMAN RECRUIT
AW	AVIATION ASW OPERATOR		
AO	AVIATION ORDNANCEMAN		
AQ	AVIATION FIRE CONTROL TECHNICIAN		
AQB	(BOMB DIRECTOR)		
AQF	(FIRE CONTROL)		
AC	AIR CONTROL		

APPENDIX H (CONT'D)

GROUP X (MEDICAL)

HM	HOSPITAL CORPSMAN
HN	HOSPITALMAN
HA	HOSPITAL APPRENTICE
HR	HOSPITAL RECRUIT

GROUP XI (DENTAL)

DT	DENTAL TECHNICIAN
DN	DENTALMAN
DA	DENTAL APPRENTICE
DR	DENTAL RECRUIT

GROUP XII (STEWARD)

SD	STEWARD
TN	STEWARDSMAN
TA	STEWARD APPRENTICE
TR	STEWARD RECRUIT

APPENDIX I

CHI-SQUARE TESTS OF INDEPENDENCE

H_0: there is no difference between the respondent and nonrespondent groups with respect to the demographic variable under consideration in Table 1, i = 1, . . . , 6, 10, 11

H_1: the respondent and nonrespondent groups differ with respect to the demographic variable

Test Statistic:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(O_{ij}-E_{ij})^2}{E_{ij}}$$

where O_{ij} = observed number of cases categorized in i^{th} row of j^{th} column

E_{ij} = number of cases expected under H_0 to be categorized in i^{th} row of j^{th} column

r = the number of rows

k = the number of columns

Table	Demographic Variable	Computed χ^2	df=(r-1)(k-1)	Tabulated χ^2 .01,df	Conclusion
1	Age	378.83	5	15.1	Reject H_0 at α=.01
2	GCT	217.29	4	13.3	"
3	Sea/Shore Code	237.20	5	15.1	"
4	Race	41.08	4	13.3	"
5	#Enlistments	407.15	4	13.3	"
6	Dependency	369.63	8	20.1	"
10	Success (All)	331.66	2	9.21	"
11	Success (Careerists)	211.15	2	9.21	"

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